

REMARKS

Claims 1-20 are currently pending. Claims 1-20 are rejected as follows: claims 18-19 are rejected under 35 U.S.C. §101 as directed to non-statutory subject matter; claims 1-4, 7-10, 13, and 17-20 are rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Application No. 2004/0017935 to Avinash et al. ("Avinash"); claim 5 is rejected under 35 U.S.C. §103(a) as being unpatentable over Avinash in view of "Strain magnitude estimation based on adaptive incompressibility processing" by O'Donnell M. et al. ("O'Donnell"); claim 6 is rejected under 35 U.S.C. §103(a) as being unpatentable over Avinash in view of "Volumetric deformation analysis using mechanics-based data fusion: applications in cardiac motion recovery" by Shi P. et al. ("Shi"); claim 11 is rejected under 35 U.S.C. §103(a) as being unpatentable over Avinash in view of U.S. Application No. 2002/0028006 to Novak et al. ("Novak"); claim 12 is rejected under 35 U.S.C. §103(a) as being unpatentable over Avinash in view of U.S. Patent No. 7,110,616 to Ditt et al. ("Ditt"); and claims 14-16 are rejected under 35 U.S.C. §103(a) as being unpatentable over Avinash in view of U.S. Patent No. 6,016,442 to Hsu et al. ("Hsu").

The Applicant has amended claims 1, 3-6, 18 and 19. No new matter has been added. Claim 2 has been cancelled in this response without disclaimer. In view of the amendments and remarks presented herein, the Applicant respectfully traverses these rejections as set forth below.

Rejections Under 35 U.S.C. §101

Claims 18 and 19 are rejected under 35 U.S.C. §101 as allegedly directed to non-statutory subject matter. On page 4 of the Office Action, the Examiner suggests "amending the claim to embody the program on 'computer-readable medium' in order to make the claim statutory." The Applicant contends that claims 18 and 19 as previously presented were in an acceptable form. However, the Applicant has amended the claims to expedite prosecution. Accordingly, the Applicant believes claims 18 and 19 to be allowable and kindly requests the rejections under 35 U.S.C. §101 be reconsidered and withdrawn.

Rejections Under 35 U.S.C. §102(e)

Claims 1-4, 7-10, 13, and 17-20 are rejected under 35 U.S.C. §102(e) as allegedly being anticipated by Avinash. Claim 1 has been amended to include the elements recited in the previously submitted claim 2. Claim 2 has been cancelled in this response without disclaimer.

Anticipation requires that each and every element of the claim be disclosed in a single cited reference. Avinash fails to disclose at least *“calculating a measure of a local confidence in the registration of the two images with each other,” “displaying said measure of the local confidence in the registration of the two images with each other,”* and that the measure of local confidence is calculated *“from the degree of transformation required to perform said mapping.”* Specifically regarding the rejection of the “displaying” element, the Applicant notes that on page 5, lines 1-2 of the Office Action mailed March 22, 2007, the Examiner stated *“Avinash does not disclose displaying a measure of confidence”*. We agree with the Examiner’s assessment at that time.

In the rejection of the elements of claims 1 and 2, the Examiner refers to paragraphs [0027] to [0030], and in particular to the “dissimilarity measure” of Avinash. However, this dissimilarity measure is not a measure of the confidence in the registration of the two images. It is simply a measure of how similar the two images are to each other (after registration). Further, Avinash does not consider the amount or size of registration/deformation as a source of information in calculating the “dissimilarity measure”. In Avinash, that information is only used in performing registration and not for any other purpose. In contrast, in an embodiment of the present application, the information is used to display a confidence measure.

As previously stated, the “dissimilarity measure” of Avinash is not the same as the confidence measure in the present application. The distinction can be illustrated by way of several examples. In a first example, imagine that a first image is taken of a patient, and then a second image is taken, a few months later. During that period, there has been a genuine change in the patient's condition (e.g. a cancerous growth). The two images may be perfectly and correctly registered together, but nevertheless, because of the actual change in the patient, the dissimilarity measure will correctly be high in the

area of the cancerous growth. In Avinash, the goal is just to highlight the area of change to the clinician. Accordingly, Avinash takes two registered images and then calculates how similar the two images are to each other (either by comparing intensities with a simple subtraction, or with an "enhanced division method"). Again, the objective is to simply highlight areas where the two images are different.

In another example to distinguish Avinash from the claims of the present application, imagine that there has been no actual change in patient condition between the two images, but because of differences in patient posture, position or respiration, one of the images must be considerably deformed to register it with the other. As a result of the registration there may be almost no difference between the two images, and then the dissimilarity measure of Avinash would be low. However because of the large deformation required to register one image with the other, the registration confidence would not be high. (This is right because, for example, in performing this deformation it is possible that the registration method will mis-identify image features, causing them to be aligned in the registered image by using a significant deformation). Thus, an embodiment of the claims of the present application would warn the clinician by displaying the registration confidence that the confidence is low, even though there is little difference between the two images.

As the foregoing illustrations make clear, the "dissimilarity measure" of Avinash is not the same as a "local confidence in the registration" as presently claimed. Again, the Avinash dissimilarity measure is how much difference there is after registration whereas the confidence measure of the present application is how much is needed to achieve registration. The language of claim 1 illustrates this distinction by providing that the measure of local confidence is "*a measure of local confidence in the registration of two images with each other*". Furthermore, claim 1 as presently amended specifies that this measure of local confidence is calculated "*from the degree of transformation required to perform said mapping*". As previously noted, this element is also not disclosed in Avinash. The dissimilarity measure of Avinash is calculated either by subtracting intensities, or by an "*enhanced division method*". Neither of these is based on the "*degree of transformation required to perform said mapping*" as presently claimed.

Therefore, again, Avinash fails to teach at least “*calculating a measure of a local confidence in the registration of the two images with each other,*” “*displaying said measure of the local confidence in the registration of the two images with each other*” and that the measure of local confidence is calculated “*from the degree of transformation required to perform said mapping*” as provided in independent claim 1. Thus, in view of the amendments and arguments presented herein, the Applicant asserts that the rejection of claim 1 and all claims depending therefrom is improper. Accordingly, the Applicant respectfully requests that the rejection of claims 1-4, 7-10, 13, and 17-20 under 35 U.S.C. §102(e) be reconsidered and withdrawn.

Rejections Under 35 U.S.C. §103(a)

Claim 5 is rejected as allegedly being unpatentable over Avinash in view of O'Donnell, claim 6 is rejected as allegedly being unpatentable over Avinash in view of Shi, claim 11 is rejected as allegedly being unpatentable over Avinash in view of Novak, claim 12 is rejected as allegedly being unpatentable over Avinash in view of Ditt, and claims 14-16 are rejected as allegedly being unpatentable over Avinash in view Hsu. To establish a *prima facie* case of obviousness the Examiner has the burden of establishing that the teachings of more than one reference may be considered in combination provided one of ordinary skill in the art would combine the references in that way to solve the problem facing the inventor and that the combination of the cited references disclose every element of the pending claims. *KSR International Co. v. Teleflex Inc.* 127 S. Ct. 1727, 1734 (April 30, 2007). Applicants respectfully submit that the Examiner has not met that burden.

Claims 5, 6, 11, 12 and 14-16 are each dependent on independent claim 1. As noted in the previous section, the Examiner has failed to show that each element of independent claim 1 is anticipated by Avinash. Further, the Examiner has not asserted that the elements of independent claim 1 of the present application, not taught in Avinash, are disclosed in any of the references cited with regards to the rejections under 35 U.S.C. §103(a). Accordingly, all claims 5, 6, 11, 12 and 14-16 depending on claim 1 are

allowable over the cited references for at least the reasons set forth in the previous section.

Specifically regarding the rejection of dependent claims 5 and 6, the Applicant further offers the following distinctions between the cited references and the claims of the present application.

Regarding the rejection of claim 5 under 35 USC S. §103(a) as being unpatentable over Avinash in view of O'Donnell. O'Donnell is concerned with tracking heart wall motion in Doppler ultrasound images. The goal of the tracking is to identify the wall in each image so that its position can be known in each image. Identifying the wall in each image allows the amount of movement of the heart wall through the sequence to be measured, identifying areas that may be diseased (and thus moving abnormally). In contrast, the claims of the present application, are concerned with registering two images with each other. In other words, an embodiment of the present application provides that the goal is for two images to be superimposed with corresponding image features lined up. This is not the same as tracking.

Therefore not only is O'Donnell concerned with a different technology, but also a different objective than the claims of the present application. The particular problem faced by O'Donnell is that in the ultrasound technique being used lateral displacements are much less precisely measured than axial displacements. Because movement of the heart wall involves axial and lateral displacement, errors in measuring the lateral displacement can result in errors tracking the heart wall and thus errors in measuring its movement and identifying abnormal regions. To overcome this problem, O'Donnell proposes deriving a "*confidence weight*" associated with each pixel's measured displacement. Then, in deciding on the position of the heart wall (that would be made up in the image of a line or stripe of pixels across the image), pixels with a low confidence weight are down-weighted (see the paragraph below Figure 5). Thus, the tracking of the heart wall is based predominately on pixels whose "*correlation weight*" is high, meaning pixels whose individual displacement is more accurately measured.

Again, O'Donnell fails to teach registering two individual images. Avinash describes two images that are registered by using both small, rigid body registration

transformation and also warped, elastic transformations (see e.g., paragraph [0024]). O'Donnell, which ignores certain pixels in tracking a feature through a series of images does not cure the deficiencies of Avinash. Further, O'Donnell does not adequately supplement the teachings of Avinash regarding the idea that confidence in the registration of two images can be based on the amount of deformation required to line them up. Therefore, the rejection of claim 5 as obvious in view of the combination of Avinash and O'Donnell is improper.

Regarding the rejection of claim 6 under 35 USC S. §103(a) as being unpatentable over Avinash in view of Shi. Like O'Donnell, Shi is also concerned with cardiac movement in an image sequence. In Shi, the cardiac surface is represented as a triangulated surface as illustrated in Figure 1. The objective is to track the movement of the individual triangles through a sequence of images. In comparing two successive frames of the sequence there are likely to be several candidates in a second frame for each triangle in the first frame. For example, page 93 of Shi discloses the use of a "*confidence measure*" for helping to identify which of the triangles in the second sequence is likely to correspond to any individual triangle in the first sequence. These pairings define candidate transformations. The pairings are found by selecting the candidate that minimizes the bending energy of the surface. In particular, the bending energy implied by each candidate pairing or transformation is calculated, and a quantity indicating the uniqueness of that choice is also calculated. These two measures are combined together in Equation (6) to give a confidence measure for the pairing, i.e. the matching of a triangle in the first image frame with a triangle in the second image frame. Such pairings are calculated for the whole surface but some will be associated with the higher confidence measure than others. To calculate the motion field representing the actual movement of the cardiac wall, the transformations that have a low confidence are smoothed over by (i.e. they tend to be ignored in favor of) nearby transformations that have a high confidence.

Therefore, it is evident that the "confidence measure" identified in Shi is not the same as the use of confidence measures in the claims of the present application. In one embodiment of the present application, claim 6 provides that the measure of confidence is

calculated from a local change in volume. This is not true of Shi. In Shi the measure of confidence is calculated from a bending energy of a surface implied by a certain correspondence between two triangles. Furthermore, the confidence measure in Shi is not displayed as a measure of the confidence in the registration of two images. Instead it is used to up-weight or down-weight individual vectors (transformations) making up the deformation field of the cardiac wall. Therefore, the combination of Shi and Avinash do not teach each and every element of the present claims. Accordingly, the rejection of claim 6 as obvious in view of the cited references is improper.

Similarly, with regards to dependent claims 11, 12 and 14-16, the teachings of Avinash in view of Novak, Ditt and Hsu respectively, do not support the rejections under 35 U.S.C. § 103(a). Therefore, in addition to the reasons presented in opposition to the rejection of independent 1, dependent claims 5, 6, 11, 12 and 14-16 are also allowable since the teachings of the cited references offered in connection with the § 103(a) rejection, in combination with Avinash, fail to teach each element as presently claimed. Accordingly, the Applicant kindly requests the rejection of dependent claims 5, 6, 11, 12 and 14-16 to be reconsidered and withdrawn.

CONCLUSION

Applicants respectfully submit that this patent application is in condition for allowance. Should the Examiner have any questions, the Examiner is encouraged to telephone the undersigned.

Applicants hereby request a two-month extension of time under 37 CFR 1.136(a) and authorizes the Patent Office to charge the Deposit Account No. 11-0171. No additional fee is believed to be due with respect to filing this amendment. If any additional fees are due, or an overpayment has been made, please charge, or credit, our Deposit Account No. 11-0171 for such sum.

If the Examiner has any questions regarding the present application, the Examiner is cordially invited to contact Applicant's attorney at the telephone number provided below.

Respectfully submitted,

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